



116

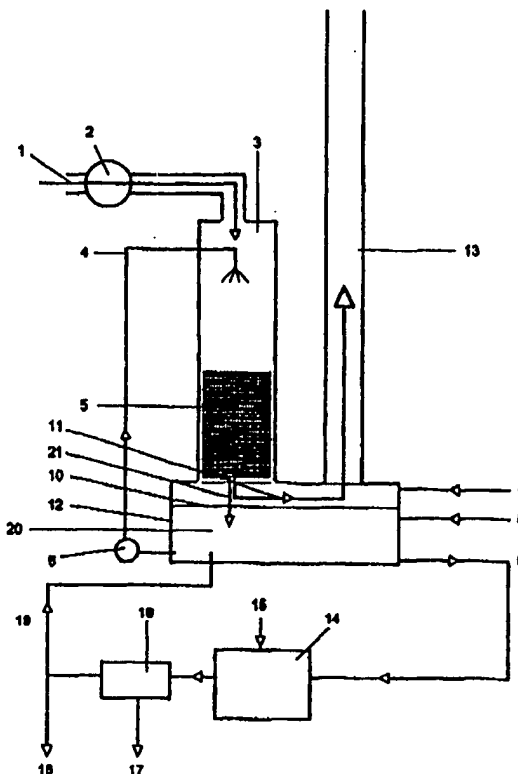
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : B01D 53/64, 53/50, 53/78		A1	(11) International Publication Number: WO 98/16301
			(43) International Publication Date: 23 April 1998 (23.04.98)
(21) International Application Number: PCT/NO97/00274			(81) Designated States: CA, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE). Published <i>With international search report.</i> <i>In English translation (filed in Norwegian).</i>
(22) International Filing Date: 10 October 1997 (10.10.97)			
(30) Priority Data: 964384 15 October 1996 (15.10.96) NO 970306 24 January 1997 (24.01.97) NO			
(71)(72) Applicant and Inventor: THOMASSEN, Thomas [NO/NO]; N-4780 Brekkestø (NO).			
(74) Agent: OSLO PATENTKONTOR AS; Postboks 7007 M, N-0306 Oslo (NO).			

(54) Title: A METHOD FOR REMOVING MERCURY AND SULPHUR DIOXIDE FROM GASES

(57) Abstract

A gas washing water consisting of sea water provided with sodium hypochlorite to give a redox potential in the range 600–800 mV is fed co-currently with a flue gas containing mercury and SO₂ gas downwards through a bed of limestone to a collection tank beneath the limestone bed. Even if the oxidation of the SO₂ gas to give sulphuric acid, the pH of the gas washing water will remain within 5–6 units, and 90–93 % of the total amount of mercury in the flue gas from the foundry is removed after a residence time of only 0.05–0.1 second in the limestone bed. The gas washing water is purified with respect to mercury by a common sulphide precipitation, and precipitated gypsum in the gas washer will act as an *in situ* filter aid for the minute sulphide particles, such that the subsequent filtration can easily be carried out. The purified gas washing water contains less than 1 µg Hg/liter.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	ES	Spain	LS	Lesotho	SI	Slovenia
AM	Armenia	FI	Finland	LT	Lithuania	SK	Slovakia
AT	Austria	FR	France	LU	Luxembourg	SN	Senegal
AU	Australia	GA	Gabon	LV	Latvia	SZ	Swaziland
AZ	Azerbaijan	GB	United Kingdom	MC	Monaco	TD	Chad
BA	Bosnia and Herzegovina	GE	Georgia	MD	Republic of Moldova	TG	Togo
BB	Barbados	GH	Ghana	MG	Madagascar	TJ	Tajikistan
BE	Belgium	GN	Guinea	MK	The former Yugoslav Republic of Macedonia	TM	Turkmenistan
BF	Burkina Faso	GR	Greece	ML	Mali	TR	Turkey
BG	Bulgaria	HU	Hungary	MN	Mongolia	TT	Trinidad and Tobago
BJ	Benin	IE	Ireland	MR	Mauritania	UA	Ukraine
BR	Brazil	IL	Israel	MW	Malawi	UG	Uganda
BY	Belarus	IS	Iceland	MX	Mexico	US	United States of America
CA	Canada	IT	Italy	NE	Niger	UZ	Uzbekistan
CF	Central African Republic	JP	Japan	NL	Netherlands	VN	Viet Nam
CG	Congo	KE	Kenya	NO	Norway	YU	Yugoslavia
CH	Switzerland	KG	Kyrgyzstan	NZ	New Zealand	ZW	Zimbabwe
CI	Côte d'Ivoire	KP	Democratic People's Republic of Korea	PL	Poland		
CM	Cameroon	KR	Republic of Korea	PT	Portugal		
CN	China	KZ	Kazakhstan	RO	Romania		
CU	Cuba	LC	Saint Lucia	RU	Russian Federation		
CZ	Czech Republic	LI	Liechtenstein	SD	Sudan		
DE	Germany	LK	Sri Lanka	SE	Sweden		
DK	Denmark	LR	Liberia	SG	Singapore		
EE	Estonia						

A method for removing mercury and sulphur dioxide
from gases

5 The present application refers to an improved process and
device for the removal of mercury and sulphur dioxide from
flue gases from, for example, foundries, power stations,
refuse disposal plants, and crematories, by washing the gas
with chloride containing water, such as sea water, to which
10 is added an oxidizing agent which oxidizes all of the
mercury to Hg(II) ions, and by using such high redox value
in the washing water that Hg⁺ salts cannot precipitate. The
gas and the washing water are passed co-currently down
through a bed of consumable limestone. The mercury(II) ions
15 will then dissolve easily in the chloride containing wash-
ing water, as a chloride complex, and the oxidized sulphur
oxide is converted to sulphuric acid being neutralized by
the consumable limestone, such that the pH value of the
washing water remains almost constant without the need for
20 using an aqueous solution of sodium hydroxide as a neutral-
izing agent. Further, the bed of limestone will be func-
tioning as a turbulent mixer of gas and washing water for a
rapid oxidation, and since the limestone is slowly con-
sumed, deposits such as gypsum and dust will continuously
25 be washed away from the limestone gravels without clogging
the bed.

The present process is carried out by adding to the gas
washing water containing 30-40 g chlorides/liter an oxidi-
30 zing agent, such as sodium hypochlorite, until the redox
potensial of the water is within the range 600-800 mV. The
gas washing water and the flue gas are fed co-currently
down through the lime stone bed, in which they are mixed
intimately for a rapid reaction and absorption of the
35 mercury in the aqueous phase.

As flue gases also often contain SO₂ gases, sulphuric acid

is formed by the acidation which reduces the pH value of the gas washing liquid.

5 According to the invention, the gas is passed co-currently with the gas washing water through the bed of, for example, limestone. The limestone will neutralize the acid(s), and hence the pH of the gas washing water will remain nearly constant in the range 5-6 pH units, and thus completely eliminate the need for the use of aqueous sodium hydroxide, 10 as well as the possibility of SO₂ reducing the oxidized mercury to Hg⁰ salts which can precipitate or to metallic Hg which is reintroduced into the flue gas.

15 The bed of consumable limestone is constantly washed with the gas washing liquid, so that dust and formed sulfates, such as gypsum and other particles, are continuously washed into a collection tank arranged below the gas washing tower, from which the washing water is conducted to a adjacent water purification plant in which the mercury is 20 removed as sulfide by common precipitation.

Gypsum particles and other particles act as an *in situ* filter aid for the minute precipitated mercury sulphide particles in the water purification plant, thus easing the 25 separation of mud and water, for instance by filtration, and the chloride water, which will be practically devoid of mercury (<1 µg Hg/l), can either be disposed to a recipient or returned to the gas washer.

30 In addition, it is preferred to conduct the gas and the gas washing water co-currently down through the bed of limestone and into the collection tank for the gas washing water, in which tank the gas washing water and the gas phase meet the surface of the water in the tank. The water 35 droplets in the gas phase will then be absorbed on the water surface by adjusting the distance between the bed of limestone and the water surface in the collection tank for

the gas washing water as well as the length of said surface, before purified gas is exhausted to a chimney. This will eliminate the need for complicated drip-catchers, being in common use in counter current gas washing.

5

It is known that the mercury in the flue gases exists both as oxidized mercury and metallic mercury vapour. The metallic mercury vapour is the most difficult to remove with wet washing of the flue gas, as the vapour must be oxidized before it can be absorbed in the gas washing water.

10

Flue gases from foundries and power stations have a relatively even content of mercury and other gases, such as SO₂, which reduces the mercury to metallic vapour in the flue gas, which can contain from 10-20 µg Hg/Nm³ up to 300-500 µg Hg/Nm³.

15

The smoke gases from refuse disposal plants and crematories show large variations in the concentration of mercury. The concentrations can be 100-10.000 µg/Nm³ gas over a short period of time, 5-10 minutes, due to sources containing large amounts of mercury, such as dental amalgam.

20

A wet wash process for effective removal of mercury hence must have very quick reaction kinetics to be able to handle these relatively short and intense peaks of mercury in the flue gases.

25

In accordance with the invention, it is preferred to add sodium hypochlorite to a gas washing water based on sea water, such that the redox potential of the sea water remains in the range 600-800 mV, and subsequently feed the gas and the gas washing water down through a bed of limestone, such that the pH in the gas washing water stays between 4 and 6 pH units, and subsequently into a tank in which particles and the gas washing water are collected, whereafter the gas washing water is purified in an adjacent

30

35

water purification plant, and one part of the purified water is returned to the gas scrubber and one part is led to a recipient. This process removed 90-93% of the mercury from the fluid gas from a foundry at a residence time in the gas scrubber of only 0,05-0,10 seconds.

The purified flue gas contains 11-16 $\mu\text{g Hg/Nm}^3$ after purification.

The present invention is a simplification and improvement of known methods, which is in demand with the increasing concern about mercury pollution, in particular from refuse disposal plants and crematories, but also from foundries and power stations.

Oxidation of mercury with absorption in a chloride containing gas scrubber water has been described in numerous publications and patents, inter alia US patent 5.009.871.

US 5.009.871 teaches that reducing gases such as SO_2 gas reduces oxidized Hg to metallic Hg, which leaves the gas washing water and is reintroduced into the flue gases. In order to prevent this, US 5.009.871 teaches that the redox in the gas washing water must be $>300 \text{ mV}$, and preferably in the range 530-710 mV for approximately 80% reduction of the Hg contents in the flue gases.

Further, US 5.009.871 teaches that due to hydrochloric acid and other reducing gases in the flue gas from incinerators, the addition of, for example, NaOH to the gas washing water is necessary in order to give a pH of 8.

It has surprisingly been found that the teaching of US 5.009.871 concerning the addition of caustic (NaOH) to increase the pH to approximately 8 in the gas washing water is not necessary when the gas washing water and the gas is led co-currently down through a bed of limestone.

A person within the state of the art will know that at pH values of 8 in the gas washing water, carbonates are formed when CO₂ is present in the gases. The produced carbonate
5 can easily be deposited on the surface of the gas scrubber, in valves, tubes, and in tanks, and hence a pH of 8 in the gas washing water may be undesirable when the gas contains CO₂ gas.

10 Carbonate formation decreases at pH values of < 6 in the gas washing water and is completely eliminated at pH < 4.

In accordance with the invention, the pH in the gas washing water consisting of sea water is always in the range 5-6
15 units, and no formation of carbonates was observed, whereas it was observed when caustic was used at pH values of 8.

This could in no way be deduced from US 5.009.871, which describes an apparatus which bubbles a gas through an
20 aqueous solution at the rate of 1 l/min (column 8, lines 1-10).

US 3.849.267 teaches that if chlorine gas is added to a gas containing mercury before the gas mixture is fed to beds
25 consisting of, respectively, a 30 cm thick bed of 2 inch saddle formed fillings of a ceramic material, then through a 25 cm thick bed of 1 inch saddle formed fillings, then a 5 cm bed of glass wool of 4 µm fibres, and finally through a 50 cm thick bed of granulated active carbon (column 4,
30 example 5), 20-30 mg Hg/m³ to 0,02 mg Hg/m³ (= 20 µg Hg/m³) of mercury will be removed from the gas.

The present invention needs only a bed of limestone, and no bed of active carbon is necessary to obtain an exhaust gas
35 containing 10-15 µg Hg/m³, something which cannot be deduced from US 3.849.267, as the examples 1-4 of US 3.849.267 teach that without active carbon, the contents

of mercury in the purified gas is 100, 50, 100-200 and 80 $\mu\text{g Hg/m}^3$, respectively.

5 Further, US 3.849.267 teaches that mercury is deposited on the solid bodies in the gas scrubber (claim 1), and it is mentioned that the deposits are in the form of Hg_2Cl_2 (column 1, lines 46-51, and column 5, lines 5-14).

10 This is contrary to the teaching of the present invention, in which it is mandantory that all mercury is continuously oxidized to Hg^{++} and absorbed in the washing water, and is not deposited in the limestone bed.

15 Norwegian patent No. 148.962 refers to a method in which mercury is removed from a flue gas containing significant amounts of SO_2 after roasting of sulfide ores, in order to produce a sulphuric acid with a low content of mercury.

20 Removal of mercury from the gas takes place by using a washing solution containing 0,02-20 g Hg^{++} /liter.

This washing solution oxidizes the metallic mercury in the gass to Hg_2Cl_2 , which is subsequently removed in an adjacent plant.

25 On page 7, lines 14-16, it is mentioned that if the contents of mercury(II) ions in the solution (= washing solution) becomes too low, the mercury can no longer be taken up by the solution. On the same side, line 19, it is mentioned that said mercury contents preferably should be
30 between 10 and 50 mmol/l (= 2-10 g Hg/l).

In accordance with the invention, no Hg_2Cl_2 is produced, as
35 all the mercury in the flue gas is oxidized to H^{++} ions and is absorbed by the washing water as a chloride complex. This implies that the washing water in accordance with the invention in reality does not necessarily have to contain

mercury, even if in practice the contents will be 1-5 mg Hg⁺⁺ ions, or approximately 1/1000 of what is stated in NO 148.962, and even then 90-93% of the mercury, in accordance with the present invention, will be removed with a residence time in the gas scrubber of only 0,05-0,10 seconds.

At the same time all SO₂ is removed, which is not the case for NO 148.962, operating with an acid washing solution.

10 Norwegian patent NO 154.682 refers to a process for the purification of gases for metallic mercury by precipitation of Hg₂Cl₂ with a washing water containing 0,02-60 g Hg⁺⁺/liter. The essential part of NO 154.682 is that the gas is moistened to saturation at 60-70°C and then quench the
15 washing water sufficiently to cool the gas to a temperature at which the vapour in the gas condenses and thereby removes mercury containing liquid (claim 1).

In accordance with the invention, there is no need for such
20 cooling of the gas as taught by NO 154.682, as the gas and the washing water is sent co-currently through the bed of limestone and is imping on the surface of the washing water in the tank for washing water, where the descending washing water and water droplets in the gas phase are absorbed.
25 This is a preferred embodiment of the present invention.

The method of the invention operates according to a principle contrary to the teachings of NO 154.682, which operates according to the counter-current principle, in
30 which the washing water descends and the gas ascends. As known to the person within the state of the art, the counter-current principle produces particles in the gas, and hence cooling of the gas or an efficient drop catcher is essential when the washing water contains up to 2-10 g
35 mercury/liter.

EP 0.709.126 A1 discloses a method and a device for the

continuous removal and precipitation of mercury from gases. The washing solution in accordance with example 2 contains 8 g Hg(II)/l, 13 g/l SCN^- , 10 g/l sulphuric acid and 2 g/l active carbon. H_2S gas is added to the gas to be purified,
5 which is not necessary according to the instant invention.

The device used in EP 0.709.126 A1 is a counter-current scrubber with a drop catcher after the reactor, which in turn is filled with "filler bodies", which must be under-
10 stood as being inert (=insoluble) in the solution and gas flowing through the reactor.

In accordance with the invention, both mercury, in the form of a Hg(II) complex, and the SO_2 gas in the flue gas, in
15 the form of sulphuric acid, are washed away by using sea water to which an oxidizing agent is added, then the gas and the washing water are passed counter-currently down through a bed of consumable carbonates in which the sulphuric acid is neutralized, and the washing water with the
20 absorbed mercury, as well as solid particles, pass through the carbonate bed and into the tank for washing water beneath the carbonate bed, then imping on the surface of the washing water, and thus the water droplets in the gas phase are absorbed without the need for a subsequent drop
25 catcher. This is the preferred mode and device for carrying out the present invention.

The invention represents a greatly simplified process and device for removing mercury and SO_2 from flue gases, and we
30 are of the opinion that this combination of method and device for carrying out the method cannot be deduced from the above mentioned patents/applications or literature and other publicly accessible publications known to the applicant.

35 Another method for carrying out the invention, instead of adding sodium hypochlorite to the gas washing water, is to

pass an electric current through the chloride containing sea water. This produces chlorine gas, which keeps the redox potential at the desired level. Other oxidizing agents can also be used, such as peroxides and per-sulphates.

It is also within the scope of the invention to utilize other carbonates than limestone (calcit), such as dolomite, chalk, shell sand, and magnetite.

It is a requirement that the carbonate medium has a low solubility in hot water, such as limestone (calcit) with a solubility of approximately 0,02 g/l water, og magnesium carbonate (magnecite) with a solubility of approximately 0,1 g/l, whereas dolomite has a solubility of approximately 0,32 g/l hot water.

The present invention will now be described with reference to figure 1, where (1) indicates the gas to be purified and (2) is a fan device transporting the gas (1) into the washing chamber (3), in which the gas is washed with a washing solution (4) provided from the collection tank (12) via a pump (6), and in which the gas (1) and the washing solution (4) descend co-currently through a limestone bed (5) to exit together at the top of the tank (12), and where the washed gas (11) is transported along the surface (10) of the washing water (20) in the collection tank (12) and exhausted through a chimney (13), and the used washing solution (21) is collected in the tank (12) together with the washing water (20), in which tank an oxidizing solution (7) and a chloride solution (8) is added; the excess water (9) is led to a water purification plant (14) in which a sulphide solution (15) is added, whereafter the water and the precipitated solid particles are separated in (16), where the sludge (17) is removed, and a part of the purified chloride water is fed to a recipient (18) and the remaining part (19) is then returned to the tank (12).

The invention will be further described by the following examples.

5 Example 1

In this example the redox potentials at which SO_2 is oxidized to sulphuric acid at different pH values was established.

10

This was done by adding a fixed amount of NaHSO_3 to sea water with a known pH value. Subsequently, small amounts of potassium iodide (KI)/starch solution were added as an indicator for titration of NaHSO_3 using NaClO . When a blue colour developed, the SO_3^- was consumed, and the redox and pH were recorded. This is a common iodine titration of chloride/hypochlorite in water.

15

Table 1 Results of oxidation of SO_2 with NaClO

20

pH	Redox value (mV) at which a blue colour was noted
3,0	340
4,4	322 In accordance with the invention
6,0	290 In accordance with the invention
7,0	265
8,0	235
9,5	175

25

Comments

30

The results show that at redox values > ca. 300 mV at pH values in the range 3-6 mercury cannot be reduced by the SO_2 .

35

Example 2

A flue gas from a melting furnace was drawn through a very efficient venturi scrubber, consisting of a laboratory water jet vacuum pump.

The washing water was pumped from a collection tank for washing water by means of a pressure pump feeding the water jet pump, and hence sucking the flue gas therethrough.

In this manner a very efficient mixing of the gas and the washing water was obtained, and the progress could be observed continuously by taking gas samples both before and after the gas washer, as well as water samples from the washing water. Samples were taken at the beginning and the end of a gas measurement.

Caustic (NaOH) was used to keep pH at a constant value.

Table 2 Results, mass balance

Test	Analyses of the wash water $\mu\text{g Hg/l}$				Total amount $\mu\text{g Hg}$. Absorbed in the washing water as:	
	Start	Stop	pH	Redox	Hg^{++}	Hg^+
1	9,7	15	8,0	750	121	0
2	4,6	33	6,3	800	631	0
3	54	48	5,9	600	0	135
4	55	38	5,9	550-600	0	435
5	0	0,24	5,2	200-300	5	12

Comments

1 and 2 show that all of the mercury was absorbed in the sea water as Hg^{++} .

5

The tests 3 and 4 show that Hg is precipitated as Hg^+ at redox values ≤ 600 mV. This is indicated by the fact that the contents of Hg in the washing water declined during the test period.

10

Test 5 was carried out with pure sea water without addition of caustic or hypochlorite. Hg^{++} in the water might be due to dissolution of previously precipitated Hg^+ salts.

15

Conclusion

In order to absorb all of the mercury in sea water as Hg^{++} ions, the redox potential in the sea water must be >600 mV, at pH values in the range 6-8.

20

Example 3

The flue gas from a melting furnace was burned in a steam kettle to: CO_2 , SO_2/SO_3 and H_2O . This gas contained 100-200 μg of Hg/Nm^3 .

25

A gas purification plant which could purify up to 1000 m^3 gas/hour was used, and connected to a water purification plant as shown in figure 1.

30

Gas washing liquid: sea water

pH kept constant by means of limestone

Redox adjusted with NaClO , 15% commercial product

Recirculation of the washing water in respect to gas:

35

1 l/m^3 gas

Addition of sea water: 60 l/hour .

Table 3 Gas purification results

No.	Gas rate Nm ³ /t	Gas washing liquid		Mercury contents in gas (µg/Nm ³)		
		pH	Redox	Inlet	Purified gas	% purification
1	350	5,8	700-850	176	13	93
2	350	6,2	700-850	168	11	93
3	350	5,9	600-800	162	11	93
4	850	5,7	700-800	164	16	90

Comments

15 No carbonates were formed, and the operation was very stable, due to the stable pH value of the gas washing water.

20 In test 4, redox was varied between 600 and 800 mV to simulate variation in process conditions. This did not have any effect on the level of purification.

25 With a gas rate of 850 Nm³/h the linear gas velocity through the limestone bed was calculated at 7 m/sec, and at a residence time of only 0,055 seconds.

Even this was sufficient for purification, which shows that the instant process is very rapid and effective.

30 A mass balance of the distribution of the mercury in test 2, between the gas phase and the gas washing water, showed that close to 100% of the absorbed mercury was absorbed as Hg⁺⁺ in the gas washing water.

35 The mercury was removed from the gas washing water by a usual sulfide precipitation in a subsequent water purification plant. This was effected by adding 1,3 l/m³ washing

water from a solution of sodium sulfide (10 g/l, Na₂S) to the gas washing water in a stirred tank until the redox potential of the water was between -50 and -100 mV. Subsequently, the water and sludge were separated in a filter press. The filtrate contained < 1 µg Hg/l. The gypsum formed, and other particles, functioned so well as a filter aid that the filtering resistance in the filter press was < 0,5 bar.

10 Example 4

This example is a summary of results, showing the efficiency of the instant invention compared to venturi gas washers with and without a drop catcher.

15

Tabell 4 Results

20

Gas washer type	Gas washing water			µg Hg/Nm ³	
	pH	Redox	Raw gas	Purified gas	condence water ³⁾
Small venturi ¹ without drop catcher	5,8	600	74	9,0	63
Big venturi ² with drop catcher	5,0	690	154	52	1,1
	4,4	790	127	75	0,8
Present ³ invention	5,8	830	167	15	0,6
	5,7	640	165	16	0,9

30

Comments

- 1): The venturi washer referred to in example 2, without drop catcher. Very efficient mixing of gas and washing liquid.
- 35 2): Large venturi washer with a capacity of treating 1000 m³/hour, with drop catcher. Inferior mixing of gas and washing liquid.
- 3): Gas washer in accordance with the invention with a limestone bed with a capacity of 850 m³/hour. Very efficient mixing of gas and washing liquid.

40

Condense water*) was collected in an extra bottle before the gas analysis of the purified gas. The mercury contents of the condensed water was calculated to give the stated contribution of Hg in the gas if the condense water had been introduced into the purified gas without a drop catcher.

Further, it can be observed that the effect of a drop catcher in 2) and the effect in accordance with the invention 3), where the amount of condense water in the gas is so small that the purified gas is not polluted.

It can also be seen that the total mercury purification efficiency of the venturi washer 2) with the drop catcher is substantially lower than the purification efficiency in accordance with the invention 3), when both were tested on the same gas from a foundry.

CLAIMS:

1. A method for removal of mercury and sulphur dioxide
5 from gases by an oxidizing wet washing of the gas, oxidiz-
ing the mercury to Hg^{++} ions and the SO_2 gas to sulphuric
acid by using a chloride containing aqueous liquid, con-
taining at least 1 g chlorides/l and having pH values in
10 the range 4-8 pH units and redox values in the range 600-
800 mV, and using one or more alkaline earth carbonates,
c h a r a c t e r i z e d i n that the oxidizing chloride
containing washing water and the gas are fed co-currently
down through a stationary bed of solid bodies of alkaline
15 earth carbonates in a one-step gas washer into a tank
underneath said gas washer, wherein the gas and the washing
water is divided, such that the oxidized SO_2 gas, which
together with the washing water forms sulphuric acid, is
neutralized by said carbonate and forms a sulphate, which
is continuously washed from the solid bodies of carbonates,
20 thereby exposing new and active carbonate surfaces for
further consumption, and in which the oxidized mercury at
the same time is absorbed in the washing water as Hg(II)
chloride complexes.
- 25 2. A method in accordance with claim 1,
c h a r a c t e r i z e d i n that said solid and sta-
tionary alkaline earth carbonate is limestone.
3. A method in accordance with claim 1,
30 c h a r a c t e r i z e d i n that the oxidation of the
gas washing water preferably is effected by adding sodium
hypochlorite.
4. A method in accordance with claim 1,
35 c h a r a c t e r i z e d i n that the chloride containing
gas washing water preferably is sea water.

5. Device for carrying out the process in accordance with the claims 1-4, comprising a gas washing tower (3) with an inlet conduit (1) for gas and an inlet conduit (4) for gas washing water, a tank (12) provided underneath the gas washer (3), a purification plant (14) for purification of the gas washing water,

c h a r a c t e r i z e d i n that the inlet conduit (1) for gas and the inlet conduit (4) for activated gas washing water are provided on top of the gas washer (3), and that said gas washer (3) is provided with a bed of alkaline earth carbonates (5) near the bottom of the gas washer (3), and that underneath the gas washer (3) a tank (12) is provided, said tank (12) is provided with an outlet for consumed gas washing water (9) to a purification plant (14) for gas washing water, an outlet (6) for recirculating reactivated gas washing water (4) to the top of the gas washer (3); the tank (12) has inlets for the addition of water (8) and an oxidizing agent (7) as well as outlets for recycling of purified gas washing water (19) to the tank (12).

1/1

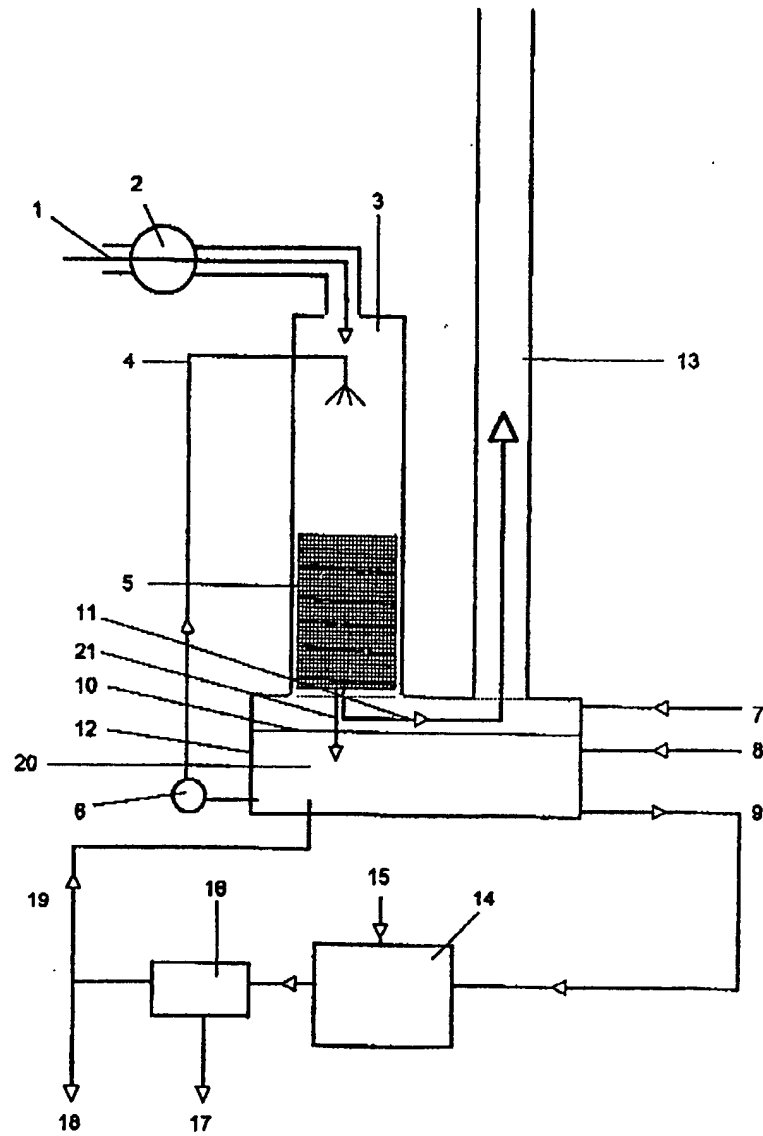


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No.

PCT/NO 97/00274

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B01D 53/64, B01D 53/50, B01D 53/78

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B01D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0706815 A2 (FORSCHUNGSZENTRUM KARLSRUHE GMBH), 17 April 1996 (17.04.96) --	1-5
A	US 5435980 A (KARSTEN S.FELSVANG ET AL), 25 July 1995 (25.07.95) --	1-5
A	US 3849267 A (HENDRIKA HILGEN ET AL), 19 November 1974 (19.11.74) --	1-5
A	US 4274842 A (LEIF A.V. LINDAU), 23 June 1981 (23.06.81) -- -----	1-5

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

13 January 1997

Date of mailing of the international search report

06 -02- 1998

Name and mailing address of the ISA/

Swedish Patent Office

Box 5055, S-102 42 STOCKHOLM

Facsimile No. +46 8 666 02 86

Authorized officer

Britt-Marie Lundell

Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT
Information on patent family members

02/12/97

International application No.
PCT/NO 97/00274

Patent document cited in search report			Publication date	Patent family member(s)	Publication date
EP	0706815	A2	17/04/96	DE 4436612 A	18/04/96
US	5435980	A	25/07/95	AT 124632 T	15/07/95
				CA 2121508 A	13/05/93
				DE 69203350 D,T	11/04/96
				EP 0613397 A,B	07/09/94
				FI 942058 A	04/05/94
				HK 187795 A	22/12/95
				WO 9308902 A	13/05/93
US	3849267	A	19/11/74	BE 797729 A	31/07/73
				CA 987074 A	13/04/76
				CH 576804 A	30/06/76
				DE 2310449 A,B,C	13/09/73
				FR 2175061 A,B	19/10/73
				GB 1373074 A	06/11/74
				JP 49000120 A	05/01/74
				NL 7202959 A	25/05/72
				SE 387102 B,C	30/08/76
US	4274842	A	23/06/81	AT 1219 T	15/07/82
				CA 1141523 A	22/02/83
				DK 265180 A	20/06/80
				EP 0013567 A,B	23/07/80
				JP 55094627 A	18/07/80
				SE 415448 B,C	06/10/80
				SE 7900209 A	11/07/80